A Real Theory of Everything

One World, Two Forces, All Scales

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Two of physics' greatest theories have refused to share a world for a hundred years. This essay argues the rift was self-inflicted — a wrong turn taken in 1926 — and that putting physics back into ordinary three-dimensional space reunites the small and the large under two forces and one equation, in a picture you can run on a laptop.

Two triumphs that refuse to share a world

Modern physics has a secret it states out loud. Its two greatest theories — quantum mechanics, which rules the world of atoms, and Einstein's General Relativity, which rules the world of stars and galaxies — do not fit together. Each is celebrated as one of the highest achievements of the human intellect. Each has been confirmed to staggering precision. And yet, asked to describe the same universe at the same time, they contradict each other. Put quantum mechanics and gravity in the same room and the equations return nonsense — infinities, paradoxes, a mathematics that breaks in your hands.

This is not a minor housekeeping problem awaiting a clever graduate student. It is a hundred-year stalemate. The split opened in 1926, when quantum mechanics took the form it still has today, and in the century since there has been no real reconciliation — no theory that contains both as special cases, no picture in which the small and the large are obviously the same world seen at different magnifications. Generations of brilliant people have tried. String theory, loop gravity, and a dozen other programs have been launched at the gap. The gap is still there.

What is strange is not that the problem is hard. What is strange is how comfortable physics has become with it. The incompatibility is treated less as a scandal than as a sacred mystery — proof of how deep nature runs. Quantum mechanics and General Relativity have been preserved, essentially untouched, in their original early-twentieth-century form. They have become *fetishes*: objects to be admired, taught, and defended, but never revised. We are allowed to build ever more elaborate structures on top of them. We are not, it seems, allowed to ask whether one of them took a wrong turn.

This essay asks exactly that. And it offers an answer that is, at bottom, almost embarrassingly simple: maybe the micro and macro worlds do not fit together because somewhere along the way we stopped describing them in the same place — *ordinary three-dimensional space* — and the way back is to put them there again.

The wrong turn

To see where things went sideways, go back to the beginning. In 1926 Erwin Schrödinger wrote down the equation that bears his name, and his first interpretation of it was beautifully concrete. The electron was a *wave in real three-dimensional space*, a little cloud of charge spread out around the nucleus, vibrating. You could picture it. You could, in principle, plot it.

Within months that picture was overruled. The wave was reinterpreted — by Max Born and the emerging Copenhagen school — not as a real thing in space but as a wave of *probability.* And for a single electron that is already a subtle move; but the deeper cost shows up with more than one particle. The wavefunction of two electrons does not live in our three-dimensional space at all; it lives in a six-dimensional space. For an atom of uranium it lives in a space of more than two hundred dimensions. For a speck of dust, the number of dimensions exceeds the number of atoms in the galaxy. This abstract space — *configuration space* — is where orthodox quantum mechanics actually does its work. It is not a space you can picture, point to, or walk through. It is a bookkeeping device of enormous power and no physical address.

That was the wrong turn: not the equation, but the decision to abandon ordinary space for an abstract one, and to trade a deterministic picture for a probabilistic one. Everything awkward that came afterward can be traced to it. Because the wave was now probability, measurement needed its own mysterious rules. Because the picture had left real space, it became natural to accept that the quantum world is simply *strange* — non-local, indeterminate, beyond intuition — and that this strangeness is a feature of nature rather than of the chosen mathematics. And when physicists later turned to the nucleus and found that the simple electric force could not, in their framework, hold it together, they did not pause to wonder whether the framework was at fault. They invented new forces.

That is the heart of the matter. The hundred-year stalemate is the price of the 1926 fetish. Keep the abstract, probabilistic quantum mechanics sacred and untouchable, and of course it will never sit comfortably beside a theory of gravity that is resolutely about real, curved, four-dimensional spacetime. The two will not share a world because one of them was quietly moved out of the world.

So here is the alternative the rest of this essay explores. What if we keep physics in ordinary three-dimensional space — for the electron *and* the planet, for the atom *and* the galaxy? What if the continuum we see is the real thing, and the discrete, probabilistic quantum is the approximation rather than the other way around? It turns out you can build a great deal of physics this way. And — crucially for our skeptical age — you can *run* it, on a laptop, and watch it work.

The one idea

Strip the proposal to its bones and it is a single picture with three parts.

First: the world is made of continuous fields in real three-dimensional space, evolving deterministically in time. No probability wave, no abstract configuration space. An electron is what Schrödinger first thought it was — a cloud of charge spread through space. A fluid is a field of density and velocity. A star is a vast ball of the same kind of stuff. The same arena, ordinary space, holds all of it.

Second: there are just two forces, and they obey the same equation. Electric charges, which come in two signs, attract and repel through the *Coulomb* force. Masses, which come in only one sign, attract through *gravity.* And here is the quiet unifying fact that the whole program leans on: the electric potential and the gravitational potential satisfy *the same mathematical law* — Poisson's equation, the two-hundred-year-old relation between a distribution of sources and the

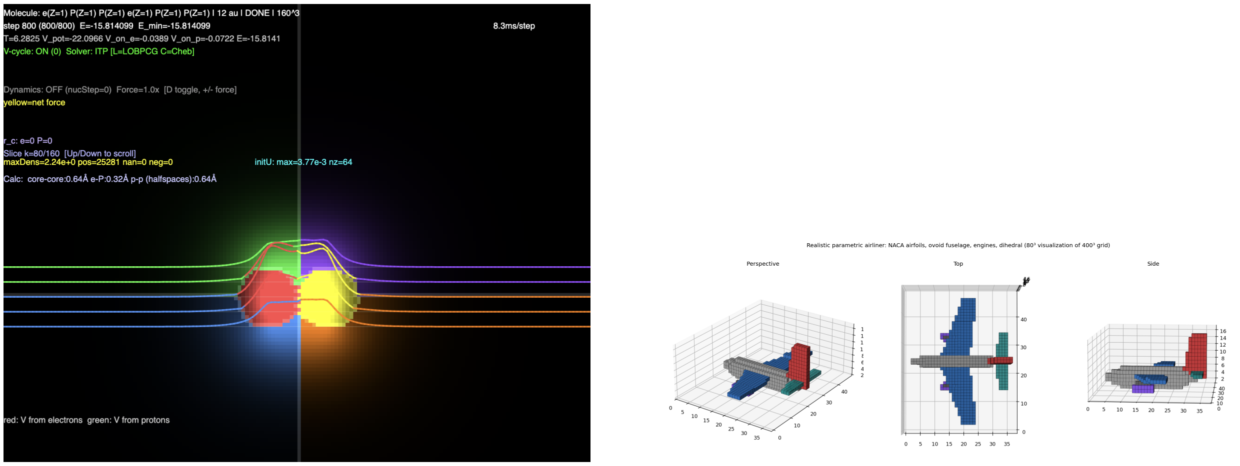

Figure 1: One continuum physics across the scales. *Left, the micro world:* two deuterons fusing into a helium nucleus — electron and proton charge clouds packed in three-dimensional space and held by the electric (Coulomb) force alone (RealQM). *Right, the macro world:* turbulent flow over an airliner, computed by the *same* finite-precision continuum mechanics at human scale (Real Thermodynamics). Different dominant force, same equations, same space — twelve orders of magnitude apart. Both run in a web browser.

field they create. One equation, two kinds of source. At the scale of atoms, Coulomb dominates and gravity is negligible. At the scale of planets, the charges have cancelled out and gravity takes over. But it is one mathematical machine running across all the scales in between. There is no strong nuclear force in this picture, and no weak force either. There are charges, and there are masses.

Third — and this is the part that makes it modern — the laws are not postulated, they are *computed*, at finite precision. This sounds like a technicality and is in fact the keystone. A real computer cannot store a number to infinite decimals; it works to finite precision, and when it solves the equations of a fluid or an atom it necessarily smooths over the very finest detail it cannot resolve. In the orthodox view that smoothing is a regrettable numerical error to be minimized. In the view offered here it is *where the physics comes from.* Irreversibility, dissipation, the arrow of time, the stability of matter — these emerge from finite-precision computation of otherwise reversible equations. Reality, on this telling, is what a finite-precision solver computes. The "laws of physics" are the output, not the input.

That third idea is what lets the same framework reach from the atom to the cosmos without bolting on new principles at each scale. And it has a consequence that should make any reader sit up: if the physics is just finite-precision computation of two Poisson-coupled forces in 3D space, then *you can do it yourself.* Every claim that follows is a small program that runs in a web browser. None of this is a thought experiment. You can press play.

The micro world you can watch

Start with the atom, where quantum mechanics is supposed to be unavoidable and strange. In the continuum picture — call it *RealQM* — the electrons of an atom are not points and not probability clouds in two-hundred-dimensional space. They are ordinary charge clouds in ordinary 3D space, each occupying its own region, packed together so they do not overlap, separated by free boundaries that the computation finds for itself. The rule is the one a child could state: arrange the negative electron clouds and the positive nucleus so that the total Coulomb energy is as low as it can go. That is it. No probability, no exclusion principle imposed by decree — the electrons stay out of each other's way because they occupy non-overlapping pieces of space.

Helium is the textbook test case: a nucleus of charge +2 with two electrons. In RealQM you give each electron half of the space around the nucleus — two clouds meeting at a plane through the center — and let the computation relax them to lowest energy. The whole simulation is, almost literally, three lines of code: update each electron cloud, update the electric potential it sits in, update the boundary between them. Run it and the energy settles to about -2.90, against a measured value of -2.904. A two-electron atom, solved to a fraction of a percent, in a picture you can watch on screen as two glowing lobes of charge.

Now scale up. The same method, applied shell by shell, computes the ground-state energies of *every atom in the periodic table* — hydrogen to the heaviest elements — to around one percent, and it does so in about a minute on a laptop. Sit with that for a moment. The orthodox computation of a heavy atom is a famously expensive affair precisely because configuration space explodes: more electrons mean exponentially more dimensions. Here the cost grows only with the number of *pixels* — the resolution of the 3D grid — because everything lives in plain 3D space. The exponential wall that makes quantum chemistry a supercomputer discipline simply is not there.

And because chemistry is just atoms sharing and trading electron clouds, the same picture runs straight into molecules: the hydrogen bond that holds water together, the covalent bonds that build organic matter, the packing of electron clouds that *is* the chemical bond. Chemistry, in this telling, is not a separate quantum mystery layered on top of physics. It is Coulomb clouds finding their lowest-energy arrangement — visibly, reproducibly, on a screen.

The nucleus without the strong force

Here the program makes its boldest move, and it is worth slowing down for.

Every textbook tells you that the atomic nucleus *cannot* be held together by electricity. The nucleus is a clump of protons, all positively charged, all furiously repelling one another at point-blank range. Something must overpower that repulsion, and since electricity only makes it worse, that something must be a new and stronger force — the *strong nuclear force* — which switches on at tiny distances and glues the protons together. A separate *weak nuclear force* is then needed to explain how nuclei decay. Two extra forces, beyond gravity and electricity, invented to make the nucleus work.

But recall the wrong turn. Those forces were introduced inside a framework that had already abandoned the idea of electrons living *among* the protons. Before 1932, physicists actually pictured the nucleus as protons *and electrons* packed together — and for understandable historical reasons they gave that picture up. The continuum program revives it, and asks a sharp question: can the nucleus be bound by the Coulomb force *alone*, if you treat the protons and the electrons inside it as equal partners — charge clouds of opposite sign, packed in 3D space, attracting across their boundaries?

The surprising answer the simulations give is *yes*. The trick is what you might call dual confinement, and it has a familiar cousin. The negative hydrogen ion — one proton holding *two* electrons — is a real, stable object: a single positive charge can bind two negatives against their mutual repulsion. Run that backwards. A single *electron* should be able to bind two *protons* around it. Put one electron cloud at the center and let two proton clouds wrap around it in opposing halves, and the whole thing holds together — by electricity alone. That little unit, two protons glued by one electron, is the deuteron: the nucleus of heavy hydrogen, the simplest compound nucleus there is.

We can watch it assemble. Seed a concentrated electron between two concentrated protons and let the computation relax: the electron spreads into a central core and the two protons settle into opposing halves around it, meeting at a plane through the core — a bound deuteron, built from a Coulomb seed, no strong force anywhere in the equations.

And then we can fuse. Take two deuterons and bring them together. As their separation shrinks, the two electron cores merge into a shared central glue and the four protons arrange themselves into a tidy outer shell — and the system slides downhill in energy the whole way, releasing binding energy as it goes. What has just happened, on a laptop, is the fusion of hydrogen into helium: the reaction that powers the Sun and the goal of every fusion reactor on Earth. In this picture it is nothing more exotic than electric charge clouds locking into their lowest-energy arrangement, and the famous fusion energy is simply the Coulomb energy released in the process.

The same logic disposes of the weak force. The free neutron is unstable; left alone it falls apart into a proton and an electron. In the orthodox account that decay requires the weak nuclear force acting on an elementary neutron. But in the continuum picture there is no elementary neutron to begin with — the "neutron" is just a single proton with a single electron, and the simulation finds that this pair *does not bind on its own.* A lone proton cannot hold one electron into a stable nuclear unit; it takes a second proton to make the bound deuteron. So the neutron's instability, and the direction of its decay into a proton and an electron, fall out of plain electric energetics — no weak force required. (An honest caveat: the neutrino that also flies out of a real decay sits outside this simple model. The claim is about the existence and direction of the decay, not its every detail.)

Take the step back and feel its size. If the nucleus is bound, and the neutron decays, by the electric force alone, then *two of the four fundamental forces of physics are not fundamental at all.* They were patches, invented to make a nucleus work inside a framework that had exiled the electron from real space. Return the electron, and the patches are no longer needed.

The macro world from the same rule

Now jump twelve orders of magnitude, from the nucleus to the everyday world of heat, fluids, and engines — and watch the *same* engine run.

Thermodynamics has its own century-old puzzle, the Second Law: heat flows from hot to cold, engines waste energy, time runs one way, entropy increases. The orthodox explanation reaches for statistics and probability — entropy as a measure of disorder, the arrow of time as an overwhelmingly likely accident among countless invisible molecular arrangements. It works, but it imports probability and hidden micro-states into a macroscopic world that, on the face of it, contains neither.

The continuum program — *Real Thermodynamics*, the companion volume — offers something cleaner. Take the ordinary equations of a fluid, which by themselves are perfectly reversible, and solve them the only way anyone actually can: at finite precision, smoothing over the finest swirls too small to resolve. That unavoidable smoothing *dissipates* energy, and the dissipation is irreversible — you cannot un-smooth what you never resolved. Out of it, the Second Law emerges as a *theorem about computation* rather than a statistical postulate. The arrow of time is not an accident of probability; it is what finite precision does to a reversible world. Entropy, the famously slippery quantity, is replaced by something concrete and computable: the cumulative dissipation, the energy lost to unresolved fine structure.

And again — you can run it. Joule's classic 1845 experiment, a gas rushing into a vacuum and stubbornly not cooling, is a short browser simulation. So is a piston-cylinder heat engine turning heat into work and paying the thermodynamic toll. So is the onset of turbulence over a wing. The same finite-precision continuum that bound the deuteron now drives the heat engine and the airflow.

No new principle was added at the macroscopic scale. The substrate is identical; only the dominant force and the scale have changed.

Why twelve orders of magnitude hide nothing new

This is the quiet, radical center of the whole proposal, and it deserves to be said flatly.

From a human being to the Solar System is about twelve orders of magnitude in size. The orthodox view holds that nature changes its character as you cross that range — that down at the quantum scale the world becomes irreducibly strange, non-local, probabilistic, governed by rules that have no echo in the large world, and that this strangeness is precisely what makes unification so hard. The continuum program makes the opposite bet: *nothing fundamentally new appears across those twelve orders of magnitude.* It is one continuum, in one three-dimensional space, governed by two forces that solve the same equation, computed at finite precision throughout. The electron cloud and the weather system and the spiral galaxy are the same kind of physics at different scales and under different dominant forces.

If that bet is right, the hundred-year stalemate was never a deep truth about nature. It was a consequence of describing the small world in an abstract space and the large world in real space, and then being surprised that the two descriptions would not merge. Put both back in ordinary 3D space, drop the strong and weak forces as the patches they were, and the small and the large stop being different universes. The "strangeness" that supposedly blocked unification turns out to be the shadow of the 1926 detour, not a property of the world.

The unification Einstein chased for the last thirty years of his life — a single field theory for all of physics — is reached here not by adding ever more sophisticated machinery on top of the two fetishes, but by *giving up the detour* that made them incompatible in the first place.

Why this is science, not a story

A grand claim deserves grand suspicion, and there is a fair question hanging over everything above: how is this different from any other sweeping "theory of everything" pitched to a popular audience — bold, beautiful, and impossible to check?

The answer is the one durable advantage of the whole approach: **everything here runs, and you can run it.** Because the physics is just finite-precision computation of two forces in ordinary 3D space, every claim in this essay is a small, self-contained program — a few hundred lines that execute in a web browser, no supercomputer, no special hardware. There is a public gallery of them. You can open helium and watch it settle to -2.90. You can open the deuteron and watch it assemble, then fuse two of them into helium. You can open Joule's experiment and the heat engine and watch the Second Law emerge. If a claim is wrong, the simulation will show it — diverge, give the wrong number, fail to reproduce. That is what makes this science rather than rhetoric: it is reproducible and it is falsifiable, by anyone with a laptop and an afternoon.

And it is equally important to be plain about where the program is *not* finished. Its successes are real and checkable — the periodic table to a percent, chemical bonds, the scale of nuclear binding, fusion, the Second Law from computation. Its open problems are real too, and pretending otherwise would betray the whole spirit of the thing. Nuclear magnetic moments are not yet addressed. The neutrino sits outside the decay model. The heaviest nuclei, and the full marriage with gravity at cosmological scale, are works in progress. The claim is not that every box is ticked. The claim is that a single, runnable, deterministic continuum physics already reaches across scales that the orthodox framework keeps in separate, incompatible boxes — and that this is worth taking seriously, and checking, rather than rejecting unread.

A new agent enters the story

There is one more character in this story, and it is a new one in the history of physics.

The mathematics here is human, and so is the physical vision — the insistence on real 3D space, the two forces, the finite-precision idea. But the simulations that turn that vision into something you can watch and test were built in cooperation with *artificial intelligence*. The helium that settles to -2.90, the deuteron that assembles from a seed, the two deuterons that fuse into helium, the heat engine that pays its thermodynamic toll — these were coded, debugged, and refined by human and machine working together, often in a single sitting, idea and implementation passing back and forth in minutes rather than months.

This is not a footnote. A problem that has sat in stalemate for a hundred years is, for the first time, being *computed into existence* — and the computing is a genuine collaboration between a human mind and a new kind of agent that can build, run, and inspect a physical model as fast as the idea can be spoken. Whatever one finally concludes about the physics, this is a glimpse of what theoretical science is about to become: not a lone thinker at a blackboard, nor a vast institutional machine, but a person and an AI, together, turning a picture of the world into a thing you can run. The new agent is part of how the stalemate gets broken.

A runnable world

Einstein spent his last decades looking for a unified field theory and did not find it. The lesson usually drawn is that nature is simply too deep, that the unification of the small and the large is a prize forever just out of reach. The lesson this program suggests is gentler and more hopeful: perhaps the prize was out of reach only because, in 1926, physics quietly stepped out of ordinary space and never fully stepped back.

Step back in, and a different picture comes into view. One three-dimensional world. Two forces — electricity and gravity — running the same equation from the nucleus to the cosmos. Matter as continuous clouds of charge and mass, finding their lowest-energy arrangements. The arrow of time and the stability of matter alike emerging from the simple fact that real computation has finite precision. No strong force, no weak force, no probability wave in an unimaginable space, no permanent rift between the small and the large.

It is not a theory of everything in the usual sense — not a single final equation carved in marble. It is something more modest and, perhaps, more useful: a *unified way of computing the world*, deterministic and visual and runnable, one physics across all the scales. Whether it is right is exactly the kind of question that, for once, you do not have to take on faith. You can open it in a browser and press play.

Runnable simulations and source: the RealQM/RealMolecule gallery, claes542.github.io/RealMolecule/gallery.html, and the Real Theory of Everything page, realtoe.html.